

Watershed Conditions and Flow Evaluations
Quillayute River watershed – Bogachiel River watershed

Bogachiel River watershed –

The Bogachiel River watershed composes over 24 percent of the Quillayute River watershed, covering approximately 152.6 square-miles in drainage area. The confluence of the Soleduck River and the Bogachiel River marks the beginning of the Quillayute River, which is only about 6.5 miles upstream for the coast. Precipitation varies between 150 inches annually on the southern rim about 1.5 miles west of Green Peak down to 82 inches annually at the western most watershed edge. Elevation extends up to 5474 feet above sea level on Bogachiel Peak and drops to about 30 feet at the confluence with the Soleduck River.

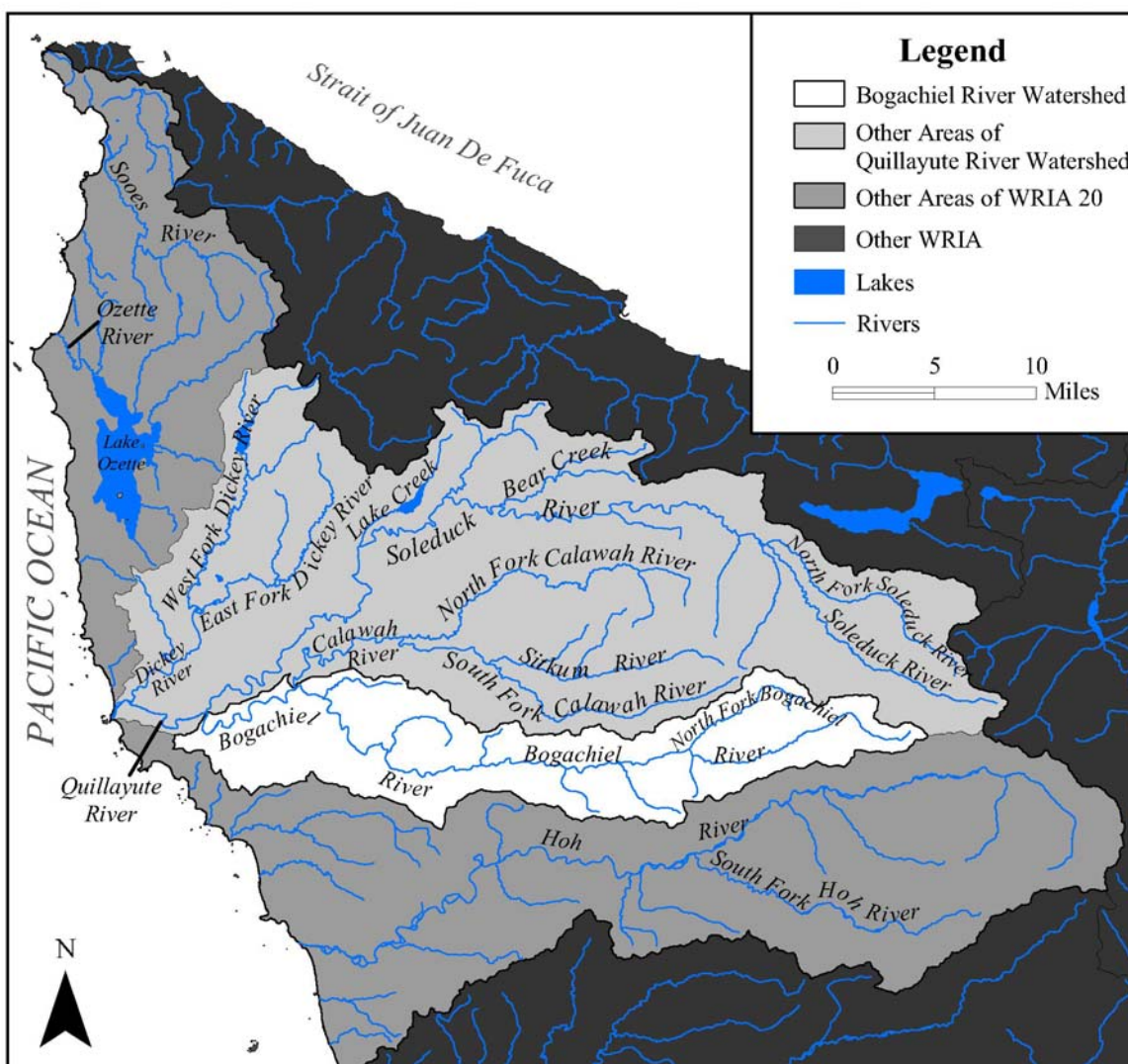


Figure 9. Location of Bogachiel River watershed within WRIA 20.

Watershed Conditions and Seasonal Variability for Select Streams within WRIA 20

The Bogachiel River watershed includes a portion of the Olympic National Park, as illustrated in Figure 10 below. The Bogachiel River watershed also contains significant areas of state administered and privately owned lands. A summary of these totals can be found in Table 11.

Table 11. Land Administration within the Bogachiel River watershed.

Land Administration	Area (sq. mi.)	Percent of Total Area
Olympic National Park	81.7	53.5
Late-successional Reserves (USFS)	9.0	5.9
State of Washington	29.2	19.1
Privately owned	32.7	21.5
Total Area	152.6	100

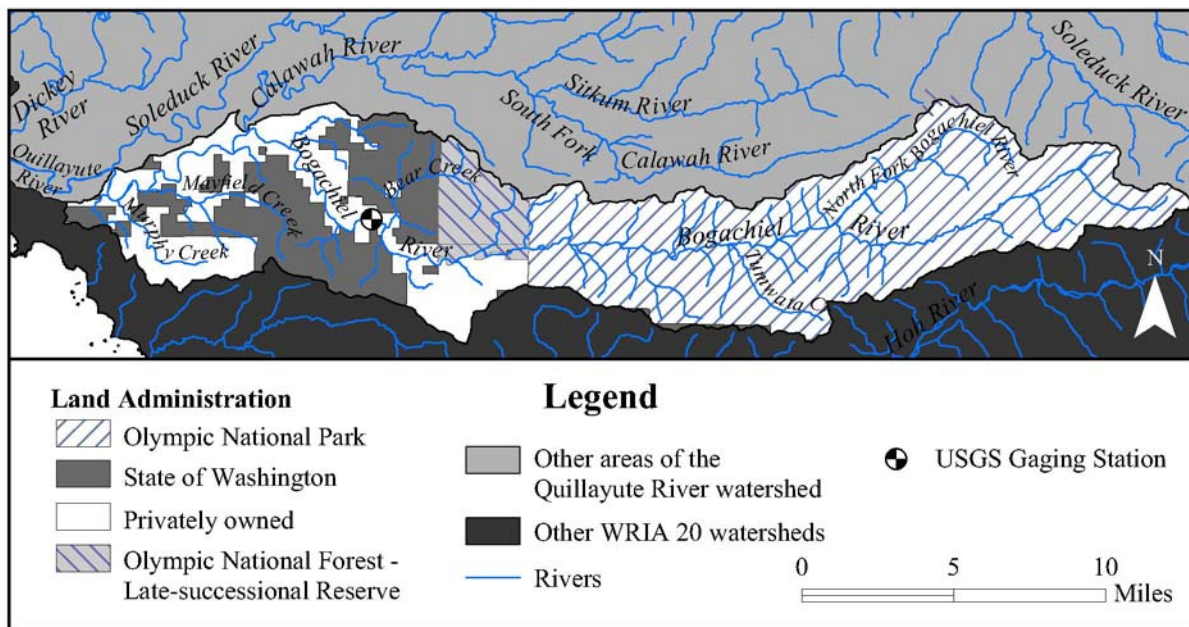


Figure 10. Land Administration within the Bogachiel River watershed.

The majority of area above the USGS gaging station 12042800 likely represents old-growth conditions, since 82 percent of the upstream area is either part of the Olympic National Park or is managed as LSR by the USDA Forest Service through the Northwest Forest Plan. In fact, the majority of the LSR in the Bogachiel River watershed was included in a Forest Service analysis of timber age class, and the resultant GIS coverage provided the information provided in Table 12 (ONF, 2000). This information identifies that about 89 percent of the Late-successional Reserve area characterized (85 percent of LSR area in Bogachiel River watershed) yields timber that are over 80 years old. As such, the

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Bogachiel gage was considered to represent undepleted or natural streamflow conditions.

Table 12. Age class descriptions of part of the timber located in the Late-successional Reserve area within the Bogachiel River watershed.

Age Class Designated by USDA Forest Service	Area (sq. mi.)	Percent of Total Area
0 - 20 years	0.85	11.2
21 - 40 years	0.01	0.1
81 - 160 years	3.04	39.9
over 160 years	3.72	48.8
Total Area	7.63	100

The Bogachiel River watershed is dominated by upland and lowland areas, which contribute more directly to streamflow in the winter months. The headwater area is characterized by highland subwatershed, where snowmelt contributes a large portion of streamflow in the spring runoff months, as well as during the winter precipitation maximum. The areas of each watershed characteristic type are illustrated in Figure 11 below, and a summary of these areas can be found in Table 13.

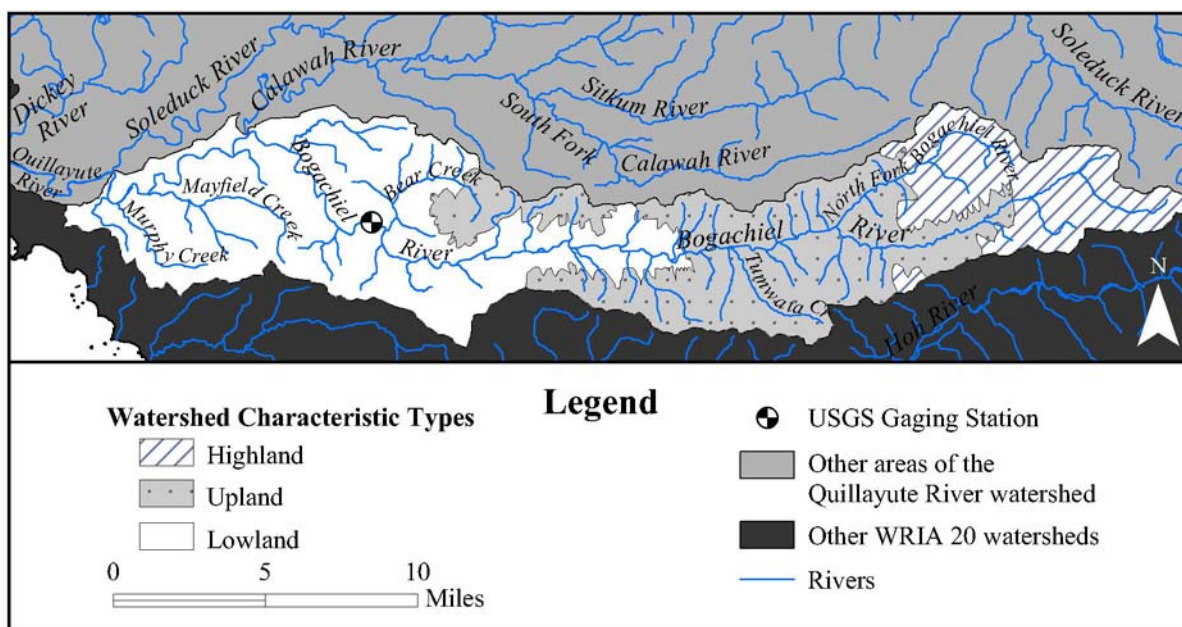


Figure 11. Watershed characteristics of areas within the Bogachiel River watershed.

Table 13. Watershed characteristics of the Bogachiel River watershed.

Watershed Characteristics	Area (sq. mi.)	Percent of Total Area
Highland	26.2	17.2
Upland	52.0	34.1
Lowland	61.3	40.2
Lowland, <i>but ineffective</i>	13.1	8.6
Total Area	152.6	100

Streamflow Evaluations of the Bogachiel River

The primary source of Bogachiel River streamflow information was from the USGS gaging station 12042800, Bogachiel River near Forks, WA. This gage collected streamflow information between April 1975 and September 1980. An extended streamflow record was created for this gage using regression techniques against two nearby streamflow gages that had overlapping periods of record with the Bogachiel River gage. These gages are:

- USGS Station Number 12043000 Calawah River near Forks, WA
- USGS Station Number 12043100 Dickey River near La Push, WA

Regressions against these gages were completed using all monthly total values in the same regression equation, whereas regression equations based on each month were developed for gages that had a greater number of months that overlapped with a nearby gage. Although these gages exhibited excellent similarities to the Bogachiel River gage (R^2 values of 0.984 and 0.969 respectively), streamflow information was not collected at any of these gages for several months in the desired period of record between October 1961 and September 1999. For these remaining 33 months, which represents approximately 7 percent of the entire period of record, monthly total streamflow was estimated for the Bogachiel River gage from an extended period of record developed for USGS gaging station 12043300, Hoko River near Sekiu, WA. This Hoko River gage was extended using local precipitation data from stations in Sappho, Clallam Bay, Forks, and Neah Bay.

Streamflow was estimated for several ungaged locations in the Bogachiel River watershed. All of these sites were located downstream of the Olympic National Park and are illustrated in Figure 12.

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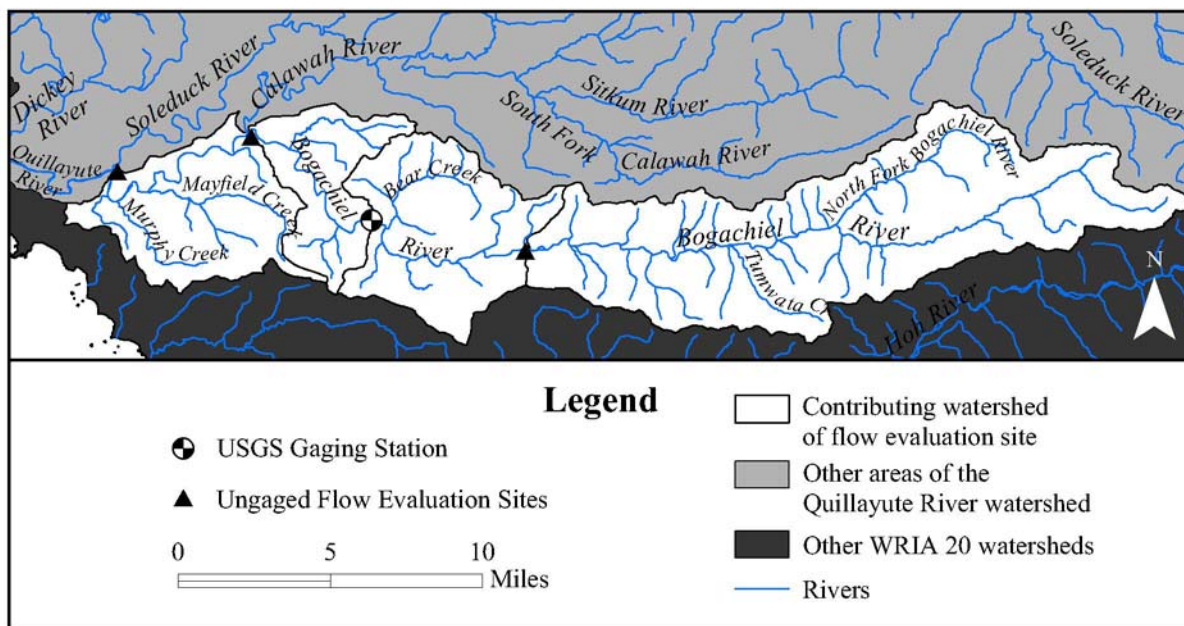


Figure 12. Flow evaluation sites within the Bogachiel River watershed.

Streamflow was estimated at the ungaged sites by the watershed characteristics method. As such, watershed characteristic information was needed for each contributing watershed. A summary of the areas within each watershed characteristic type designated by contributing watershed, as described in Table 14. Also, the average annual precipitation values used to weight streamflow in the watershed characteristics method are summarized in Table 15.

The variability of streamflow at each of these locations is described in detail below. The provided graphs illustrate the expected variation of naturally occurring streamflow for each accumulated watershed area. The range in variation is illustrated in approximate average monthly flow in cubic feet per second (cfs), and these values are summarized in the corresponding table for each evaluation site. These values are estimated from how frequent a monthly total flow occurred in the period between October 1961 and September 1999.

Watershed Conditions and Seasonal Variability for Select Streams within WRIA 20

Table 14. Watershed characteristics within each portion of the Bogachiel River watershed.

Watershed Characteristic Types	Bogachiel River at exit of Upper Bogachiel WAU	Bogachiel River at USGS gage# 12042800 - Bogachiel River nr Forks, WA	Bogachiel River above the Calawah River confluence	Bogachiel River at outlet at Soleduck River confluence
	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)
Highland	26.2	-	-	-
Upland	46.5	5.56	-	-
Lowland	4.99	23.7	11.9	20.7
Lowland- <i>ineffective</i>	3.33	0.46	4.30	4.97
Entire area	81.0	29.7	16.2	25.7

Table 15. Average annual precipitation of each portion of the Bogachiel River watershed.

Watershed Characteristic Types	Bogachiel River at exit of Upper Bogachiel WAU	Bogachiel River at USGS gage # 12042800 - Bogachiel River nr Forks, WA	Bogachiel River above the Calawah River confluence	Bogachiel River at outlet at Soleduck River confluence
	Average Annual Precip (in.)	Average Annual Precip (in.)	Average Annual Precip (in.)	Average Annual Precip (in.)
Highland	130.2	-	-	-
Upland	131.3	123.4	-	-
Lowland	128.4	120.5	112.2	97.0
Lowland- <i>ineffective</i>	128.4	115.6	108.6	92.7
Entire area	130.6	120.9	111.3	96.1

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Bogachiel River at River Mile 22.0 (outlet of Upper Bogachiel WAU) –

The most upstream flow evaluation site was chosen based on the most downstream end of the Washington Department of Transportation's Watershed Administrative Unit (WAU) called the Upper Bogachiel WAU, which is located at RM 22.0. The watershed characteristics method was used to estimate streamflow at this location based on the extended streamflow record created for the USGS gaging station 12042800, Bogachiel River near Forks. The monthly time series for this location can be found in Appendix 3.

Streamflow in the Bogachiel River exhibits the greatest indicated variation in streamflow between the months of November and February. During the late summer and into the fall, flow in the Bogachiel River recedes to minimum flow. This minimum flow season is indicated to extend into September.

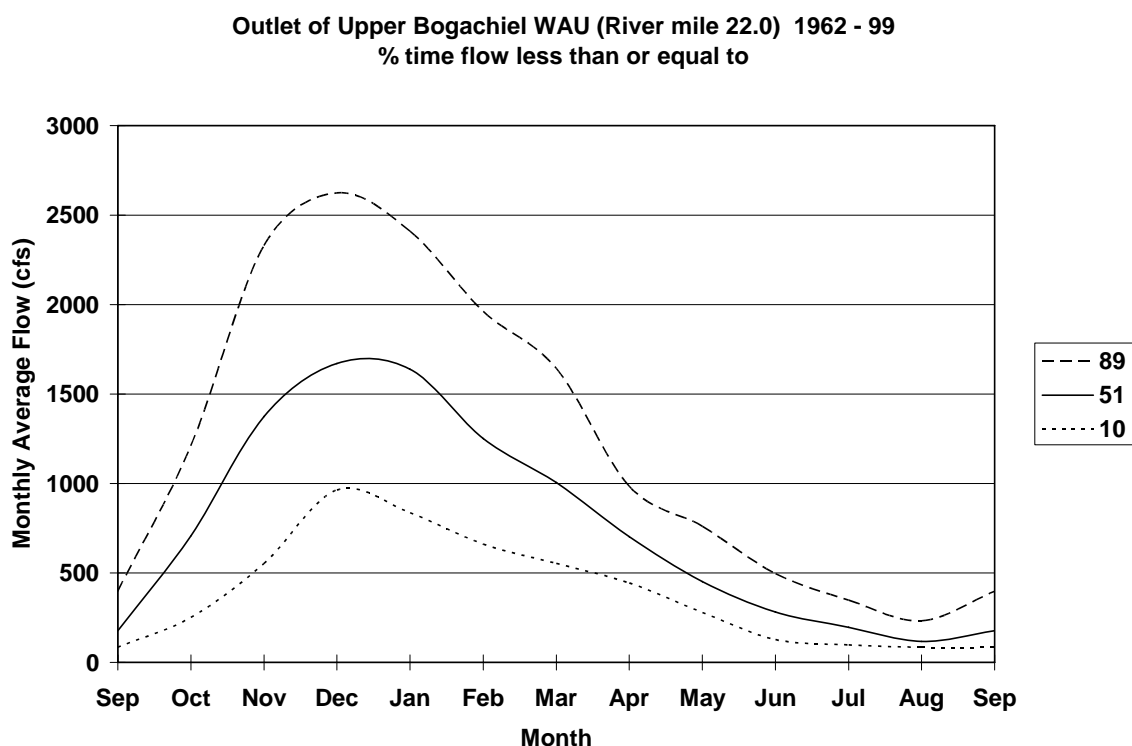


Table 16. Percent of time that average monthly streamflow (cfs) would be less than or equal to the indicated value for each month in the Bogachiel River at River Mile 22.0

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	1211	2329	2624	2409	1962	1644	984	761	496	348	233	398
51	708	1375	1670	1638	1252	1005	704	452	282	196	118	177
10	252	553	963	836	661	554	445	279	128	98	84	85

Bogachiel River near Forks (at USGS Gage 12042800) –

As described earlier, an extended period of record was generated for the Bogachiel River at USGS gage 12042800, located where U.S. Highway 101 crosses the Bogachiel River. This extended record was generated using regression techniques against other nearby streamflow gages. See the beginning of “Streamflow Evaluations for the Bogachiel River” for more information. The extended period of record can be found in Appendix 3.

The following graph illustrates the percentage of time that average monthly flow in Bogachiel River at the specified location was less than or equal to an indicated level of flow. Streamflow in the Bogachiel River exhibits the greatest indicated variation in streamflow between the months of November and February. During the late summer and into the fall, flow in the Bogachiel River recedes to minimum flow. This minimum flow season is indicated to extend into September.

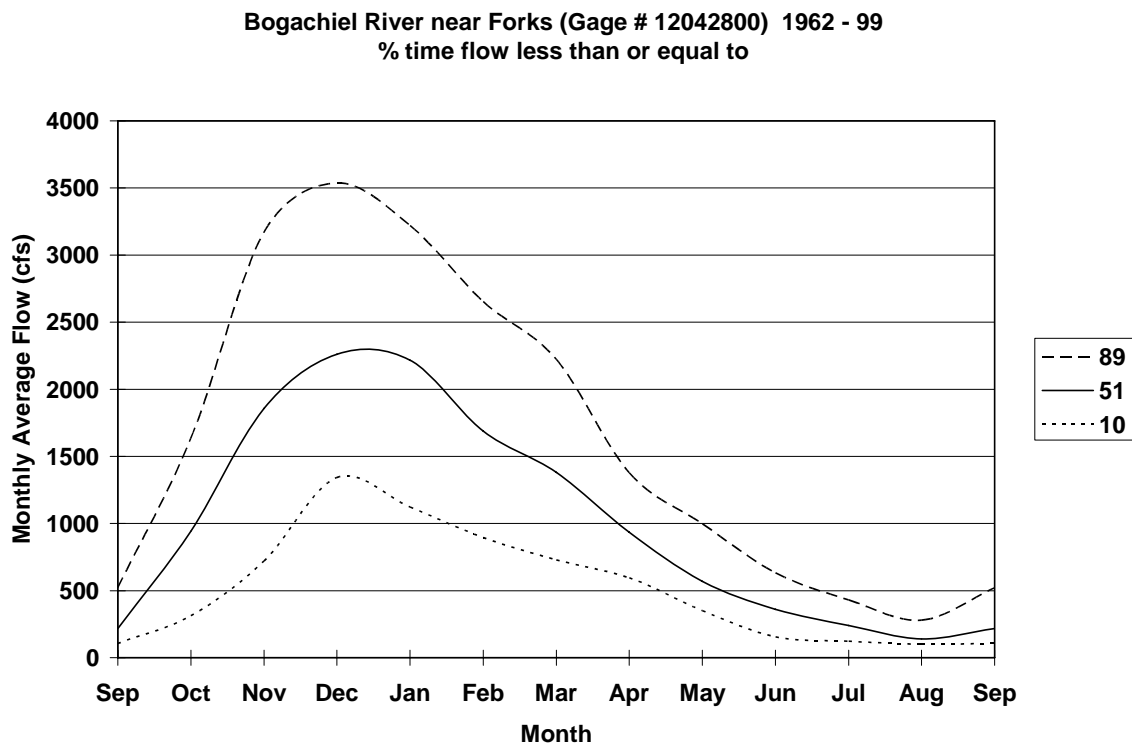


Table 17. The percent of time that average monthly streamflow (cfs) is less than or equal to the indicated value for each month at the Bogachiel River near Forks.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	1633	3170	3537	3220	2654	2224	1378	997	631	431	281	520
51	945	1857	2261	2217	1689	1381	936	569	361	240	140	218
10	313	721	1342	1122	896	730	595	350	155	123	100	106

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Bogachiel River above the Calawah River confluence –

The Calawah River outflows into the Bogachiel River at RM 8.2. Streamflow was estimated for the Bogachiel River above this confluence through applying the watershed characteristics method to streamflow information from USGS gage 12042800, and low flow months were calibrated using streamflow measurements collected by the Streamkeepers of Clallam County in the summer and fall of 2002. The extended period of record can be found in Appendix 3.

The greatest variation in streamflow of the Bogachiel River is exhibited between the months of November and February. During the late summer and into the fall, flow in the Bogachiel River recedes to minimum flow. This minimum flow season is indicated to extend into September.

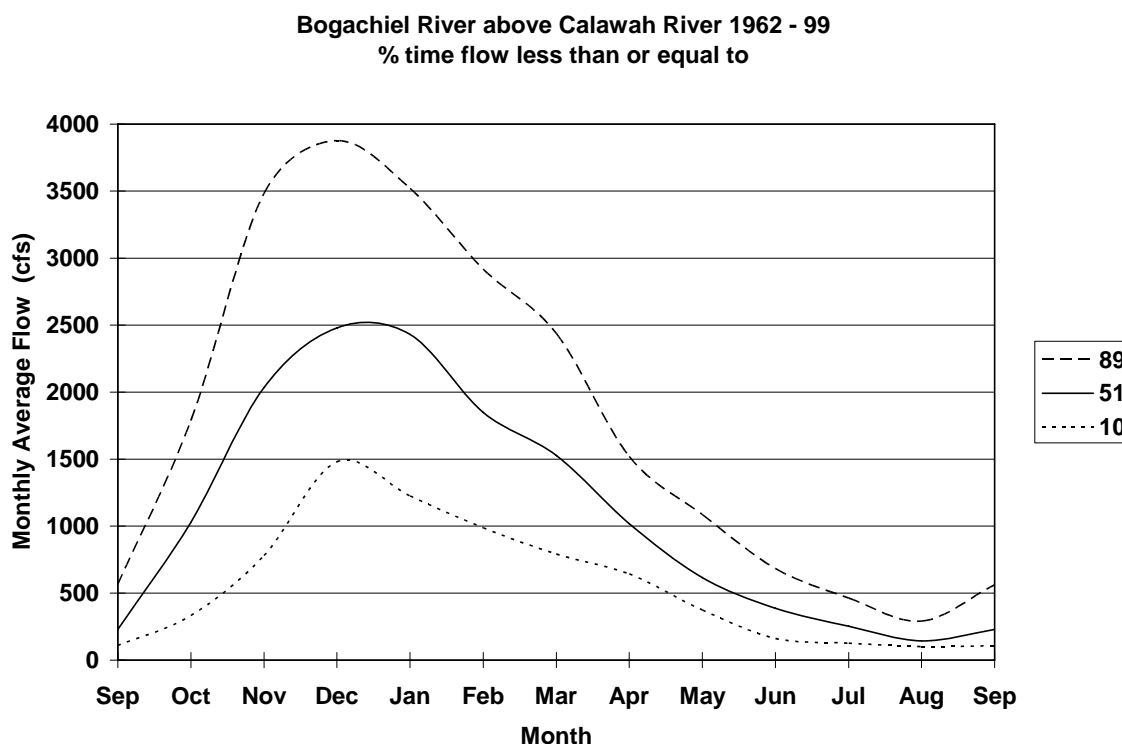


Table 18. The percent of time that average monthly streamflow (cfs) is less than or equal to the indicated value for each month at the Bogachiel River above the Calawah River confluence.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	1788	3482	3877	3521	2917	2438	1520	1086	683	462	291	562
51	1029	2035	2480	2430	1849	1527	1018	615	387	252	143	229
10	331	779	1481	1225	986	791	642	372	161	127	101	108

Bogachiel River at the Outlet –

The outlet of the Bogachiel River marks the beginning of the Quillayute River when combined with the Soleduck River, since the confluence of the Bogachiel and Soleduck Rivers marks the upstream extent of the Quillayute River. Streamflow was estimated for the Bogachiel River at the outlet through applying the watershed characteristics method to streamflow information from USGS gage 12042800, and low flow months were calibrated using streamflow measurements collected by the Streamkeepers of Clallam County in the summer and fall of 2002. The extended period of record can be found in Appendix 3.

The greatest variation in streamflow of the Bogachiel River is exhibited between the months of November and February. During the late summer and into the fall, flow in the Bogachiel River recedes to minimum flow. This minimum flow season is indicated to extend into September.

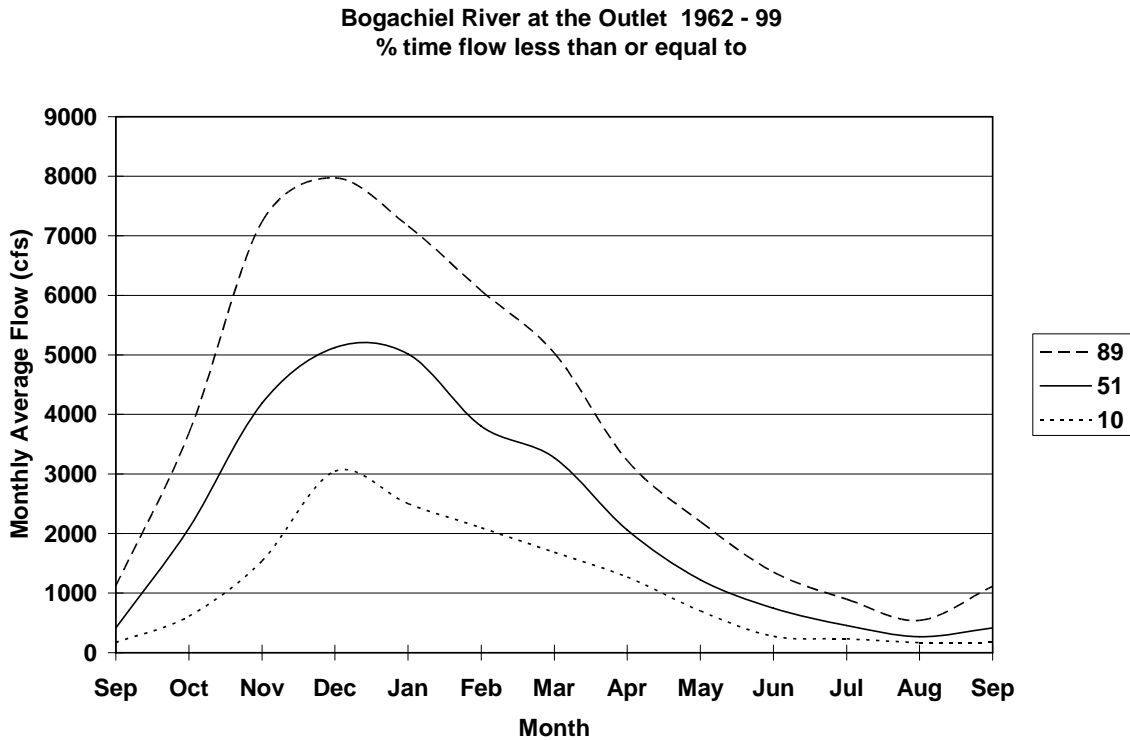


Table 19. The percent of time that average monthly streamflow (cfs) is less than or equal to the indicated value for each month at the Bogachiel River at the outlet.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	3678	7234	7972	7165	6079	5031	3225	2200	1351	896	541	1112
51	2090	4192	5122	5017	3804	3273	2057	1224	747	455	266	413
10	611	1537	3045	2503	2098	1684	1266	697	274	233	168	172